What is claimed is:

1. A pattern-detection apparatus that detects a specific pattern contained in an image, said pattern-detection apparatus comprising:

5 a binarizing unit that binarizes an input image to obtain binary image data,

a partial-image recognition unit that recognizes a partial image that is contained in said binary image data, and that is part of said specific pattern and has an empty

10 inside, and

a specific pattern determination unit that determines the said specific pattern contained in said image, based on the recognition results obtained by said partial-image recognition unit,

15 wherein said partial-image recognition unit successively scans, for said binary image data, a pixel-block area of predetermined size containing an target pixel, and said partial-image recognition unit recognizing a partial image contained in said binary image data, on the

20 condition that at least one OFF-pixel exists within a reference block consisting of said target pixel and predetermined pixels in its neighborhood within said pixel-block area.

2. The pattern-detection apparatus of claim 1, wherein

25 said partial-image recognition unit changes the size of

said reference block, depending on the size of the partial-image to be recognized within said pixel-block area.

3.   The pattern-detection apparatus of claim 1, wherein said partial-image recognition unit recognizes the partial image on at least one of the conditions that the pixels constituting the outermost lines of a pixel-block area are all OFF-pixels, and that the number of ON-pixels contained in a predetermined area with its center being at an target pixel in said pixel-block area is within a prescribed range.

4.   The pattern-detection apparatus of claim 1 having further a low-resolution conversion unit that converts the binary image data obtained by said binarizing unit to binary image data of lower resolution, wherein said partial-image recognition unit recognizes said partial image for the binary image data converted to lower-resolution image data by said low-resolution conversion unit.

5.   A method for detecting a specific pattern contained in an image, said pattern-detection method comprising steps of:

binarizing an input image to obtain binary image data,

recognizing a partial image that is contained in said binary image data, and that is part of said specific pattern and has an empty inside, and

determining said specific pattern contained in said

image based on the recognition results,

wherein in the partial-image recognition step, a pixel-block area of predetermined size containing an target pixel is successively scanned for said binary image data, and a partial image contained in said binary image data is recognized on the condition that at least one OFF-pixel exists within a reference block consisting of said target pixel and predetermined pixels in its neighborhood within said pixel-block area.

6. A computer-readable storage medium that stores a pattern-detection program for detecting a specific pattern contained in an image, said pattern-detection program comprising steps of:

binarizing an input image to obtain binary image data,

recognizing a partial image that is contained in said binary image data, and that is part of said specific pattern and has an empty inside, and

determining said specific pattern contained in said image, based on the recognition results,

wherein in that in the partial-image recognition step, a pixel-block area of predetermined size containing an target pixel is successively scanned for said binary image data, and a partial image contained in said binary image data is recognized on the condition that at least one OFF-pixel exists within a reference block consisting of said

target pixel and predetermined pixels in its neighborhood within said pixel-block area.

7. A pattern-detection apparatus that detects a specific pattern contained in an image, said pattern-detection

5 apparatus comprising:

a binarizing unit that binarizes an input image data to obtain binary image data,

a partial-image recognition unit that recognizes a partial image that is contained in said binary image data

10 and that is part of said specific pattern,

a setting device that determines similarity between a reference image and the partial image recognized by said partial-image recognition unit and sets a value corresponding to said similarity, and

15 a specific pattern determination unit that determines said specific pattern contained in said image, based on the value corresponding to said similarity and set by said setting device.

8. The pattern-detection apparatus of claim 7, wherein

20 said partial-image recognition unit successively scans, for said binary image data, a pixel-block area of predetermined size containing an target pixel and recognizes a partial image within said pixel-block area, based on a predetermined condition.

25 9. The pattern-detection apparatus of claim 7, wherein

said setting device sets values for a plurality of scanned pixel-block areas, corresponding to said similarity, and said specific pattern determination unit determines said specific pattern contained in said image, based on the

5   total value of the values set by said setting device and corresponding to said similarity.

10.   The pattern-detection apparatus of claim 7, wherein said partial-image recognition unit recognizes a partial image on at least one of the conditions that the pixels

10   constituting the outermost lines of a pixel-block area are all OFF-pixels, and that the number of ON-pixels contained in a predetermined area with its center being at an target pixel in said pixel-block area is within a prescribed range.

11.   The pattern-detection apparatus of claim 7 having

15   further a low-resolution conversion unit that converts said binary image data obtained by said binarizing unit to binary image data of lower resolution, and said partial-image recognition unit recognizing a partial image for said binary image data converted to lower-resolution image data

20   by said low-resolution conversion unit.

12.   A method for detecting a specific pattern contained in an image, said method comprising steps of:

       binarizing input image data to obtain binary image data,

25   recognizing a partial image that is contained in said

binary image data, and that is part of said specific pattern, and

determining similarity between the recognized partial image and a reference image, and setting a value
5   corresponding to said similarity, and

determining said specific pattern contained in said image, based on the set values corresponding to said similarity.

13.   A computer-readable storage medium that stores a
10   pattern-detection program for detecting a specific pattern contained in an image, said pattern-detection program comprising steps of:

binarizing input image data to obtain binary image data,

15   recognizing a partial image that is contained in said binary image data, and that is part of said specific pattern,

determining similarity between the recognized partial image and a reference image, and setting a value
20   corresponding to said similarity, and

determining said specific pattern contained in said image, based on the set values corresponding to said similarity.

14.   A pattern-detection apparatus that detects a specific
25   pattern contained in an image, said pattern-detection

apparatus comprising:

a binarizing unit that binarizes an input image data to obtain binary image data,

a partial-image recognition unit that recognizes a partial image being contained in said binary image data and being part of said specific pattern, and

a specific pattern determination unit that determines said specific pattern contained in said image, based on the recognition results obtained by said partial-image recognition unit,

wherein said partial-image recognition unit recognizes a partial image contained in said binary image data, for a pixel-block area having a predetermined size and containing an target pixel in said binary image data, based on at least one of the conditions concerning the pixels at the opposite vertices, the pixels on the outermost lines of said pixel-block area, and the pixels on the opposite sides on the outermost lines of said pixel-block area.

15. The pattern-detection apparatus of claim 14, wherein said partial image is approximately a circular image.

16. The pattern-detection apparatus of claim 14, wherein said condition for the partial-image recognition in said partial-image recognition unit is the one that the number of OFF-pixels in each pixel pair that is located at opposite vertices is less than 2.

17.   The pattern-detection apparatus of claim 14, wherein said condition for the partial-image recognition in said partial-image recognition unit is the one that the total number of ON-pixels on the outermost lines is not more than

5   a predetermined number, for the pixels on the outermost lines of said pixel-block area.

18.   The pattern-detection apparatus of claim 14, wherein said condition for the partial-image recognition in said partial-image recognition unit is the one that the total

10   number of ON-pixels on the outermost lines is not more than a predetermined number, for the pixels on the opposite sides on the outermost lines of said pixel-block area.

19.   The pattern-detection apparatus of claim 14 having further a low-resolution conversion unit that converts said

15   binary image data obtained by said binarizing unit to binary image data of lower resolution, and said partial-image recognition unit recognizing a partial image for said binary image data converted to lower-resolution image data by said low-resolution conversion unit.

20   20.   A method for detecting a specific pattern contained in an image, said pattern-detection method comprising steps of:

binarizing input image data to obtain binary image data,

25   recognizing a partial image that is contained in said

binary image data, and that is part of said specific pattern and has an empty inside, and

determining said specific pattern contained in said image, based on the recognition results,

5   said method being characterized in that in the partial-image recognition step, said partial image contained in said binary image data is recognized, for a pixel-block area having predetermined size and containing an target pixel in said binary image data, based on at

10   least one of the conditions concerning the pixels at the opposite vertices, the pixels on the outermost lines of said pixel-block area, and the pixels on the opposite sides on the outermost lines of said pixel-block area.

21. A computer-readable storage medium that stores a

15   pattern-detection program for detecting a specific pattern contained in an image, said pattern-detection program comprising the steps of:

binarizing input image data to obtain binary image data,

20   recognizing a partial image that is contained in the binary image data and is part of the specific pattern, and

determining the specific pattern contained in the image based on the recognition results,

wherein in the partial-image recognition step, a

25   partial image contained in said binary image data is

recognized, for a pixel-block area having predetermined size and containing an target pixel in said binary image data, based on at least one of the conditions concerning the pixels at the opposite vertices, the pixels on the

5   outermost lines of said pixel-block area, and the pixels on the opposite sides on the outermost lines of said pixel-block area.